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SOUTHWEST RESEARCH INSTITUTE

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A BIOLOGICAL IMPOSSIBILITY?—Shown here is a Dutch pattern gray rabbit with her three Albino young. Biologists and rabbit breeders know it is impossible for white Albinos to be born of a Dutch pattern gray mother. Yet this gray female did give birth to these Albinos—from fertilized eggs taken from an Albino doe and transferred to the gray rabbit. With funds contributed by individuals and industries which benefit from livestock improvements, Southwest Research Institute's affiliated Foundation of Applied Research is carrying its ova transfer program into its ninth year. When perfected, the method will enable ordinary scrub cows to give birth to top-quality calves. Foundation staff members have proved it is possible with small animals and are working with cattle—both the beef and dairy types.

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THIRD ANNUAL REPORT

Southwest Research Institute has just completed its third year of operation as a nonprofit, independent, public service scientific institution dedicated to the enhancement of the public welfare through the development of natural resources, agriculture, manufacturing, public health and national security, with particular responsibility for service to the Southwest region, but also serving other regions of the United States and those countries friendly to our own.

The Trustees of the Institute comprise an outstanding group of leaders from business, industry, education, agriculture, and the professions. They have been selected primarily from the six-state area served by the Institute, namely, Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, and Texas, but in addition, there is extensive representation from the nation at large and from the Republic of Mexico to enable the Institute to utilize a variety of skills, abilities, and experience in planning and directing its program of service.

The Trustees presently number 117 and from these there is elected a Board of Governors of sixteen, with an Executive Committee of seven which acts upon policy matters which arise from the time of one annual meeting until the next.

The third year of operation of Southwest Research Institute saw substantial increase in its activities, facilities and personnel.

NEW BUILDINGS AND FACILITIES

During the past year several additions were made to the physical plant. One building was completed to house the Physics Department which was created during the year, two smaller buildings were completed to house agricultural implements and to provide some laboratory office space for agricultural purposes, and another building was started which will temporarily house the library and also make available urgently needed space for the expanding program in Engineering Mechanics and Minerals Technology.

Many equipment additions were made throughout the research departments and additional substantial facilities provided in the Automotive Laboratory. Also, Machine Shop facilities were materially expanded to meet the needs of the research departments.

STAFF ADDITIONS

With the establishment of the Physics Department during the year, Paul M. Erlandson was appointed Chairman of the Department; William A. Mussen, Supervisor of Electronics; John Ohman, Senior Research Engineer; and John W. Mannix and Cheryle C. Smith as Research Physicists.

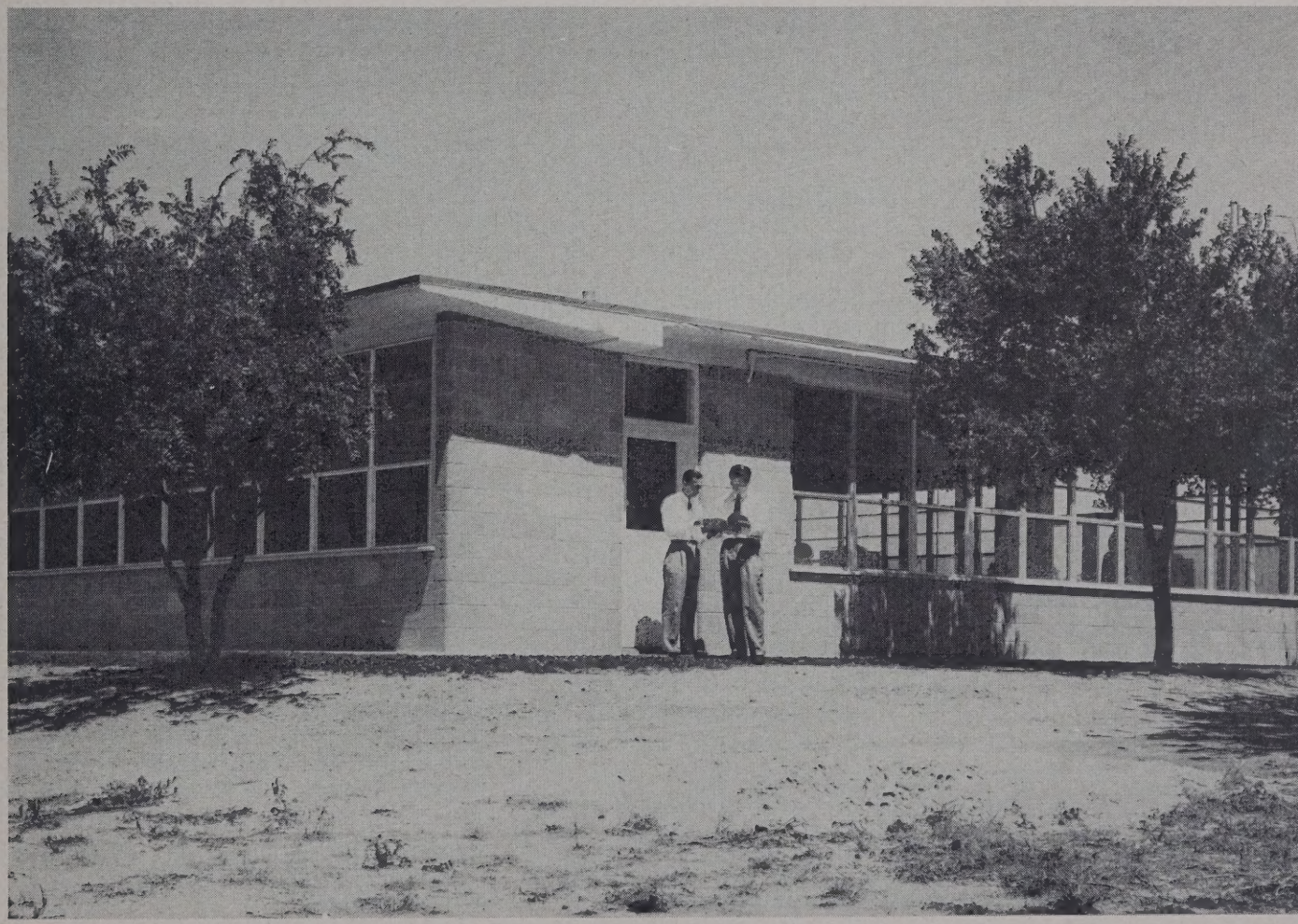
C. Desmond Pengelley was appointed Chairman of the Engineering Mechanics Department, and other additions to this department include: James M. Bright, Robert A. Doak, James P. Lincoln, Ray P. Reed and Warren A. Strutman.

Donald Abbott was appointed Director of the Special Projects Division, and new appointments to the Chemical Engineering Department include Lubertus Bakker and William J. Burkett.

John E. Funnell was added as Ceramic Engineer in the Mineral Technology Department, and Robert B. Magner as Administrative Assistant in the Housing and Construction Technology Division.

Noel H. Wood was appointed to the Agriculture Department as Agricultural Economist. In addition, a number of people were added to the various service departments of the Institute, bringing total personnel to more than 150 people.

Research in Physics, Electronics, Instrumentation.



COORDINATING DIVISIONS

Reference to the organization chart of Southwest Research Institute will show that one of the unique characteristics of the Institute is its coordinating divisions in the fields of housing and construction technology, fire technology, oceanography and meteorology, petroleum technology, special projects, and international operations.

These divisions represent the fields which careful study over a long period of time indicated as activities in which the Institute could distinguish itself. In some cases this is due to the fact that the very location of the Institute geographically makes these fields of scientific investigation important activities in order to be of maximum service to the public and to growing industries. In other cases, such as fire technology, these fields were chosen, after careful consideration and on the basis of surveys over the nation, because a great need for a coordinated research effort exists on a national scale, and the Institute can serve with distinction.

These divisions are all primarily small administrative units which act as liaison between the industries involved and the research departments of the Institute. In this way all segments of the physical sciences concerned in the solution of broad problems can be brought into clearly defined focus on each specific project.

HOUSING AND CONSTRUCTION TECHNOLOGY DIVISION

This division serves to coordinate the varied research department activities of the Institute in this important field of industrial and public interest. Research projects in housing and building construction are generally developed by the division director, who also acts as "Sponsor's Representative" in the coordination of the activities of the various research departments which are brought to bear in the solution of the problems involved in such a broad field of activity as housing and construction technology. In other words, a broad investigation in the field of housing and construction technology is broken down into specific research projects in the appropriate research departments of the Institute and the responsibility for conducting these specific phases of the over-all problem is then that of the chairmen of the research departments involved, with coordination performed by the division director.

Research projects in the housing and building construction field are more fully reported upon under the respective research departments which have the responsibility for conducting them.

Southwest Research Institute is fast becoming recognized nationally as competent and qualified in the field of housing and construction research. Some of the organizations which are now utilizing the Institute's services in this field include the Housing and Home Finance Agency, The Southern Building Code Congress, and the National Security Resources Board.

The **Revere Quality House Program** continues to be a major activity of the division. This program involves working in the field throughout the nation with merchant housebuilders and their architects to assist them in building houses of superior quality for sale to the public at moderate prices.

The success of this program may be judged by a five-fold increase in the number of houses approved in 1950 over 1949. More and more, builders are recognizing the public's demand for better quality in houses and its dissatisfaction with poorly designed housing projects. Shortages of critical materials and current credit restrictions will accelerate the trend toward quality not only as a means of conserving materials and manpower but also because larger down payment requirements will mean a market of more discriminating house buyers.

The objectives and the practical techniques for achieving quality houses, evolved by the Revere Quality House Program, are now being endorsed by the National Association of Home Builders, the American Institute of Architects, and other organizations. Achievements of the Quality House Program continue

to be presented in national and consumer publications and this recognition enables the Institute to extend the benefits of its service to an ever-widening segment of the public.

Quality in houses is a relative factor which is a composite of many important considerations. The items stressed by Southwest Research Institute are sometimes overlooked by the builders of speculative houses. Some of them are:

1. Site planning to take advantage of views, summer breezes, winter sunlight, the natural features of the site, and to provide privacy for family living, indoors and out.

2. Efficient use of space; rooms planned for more than one use wherever possible.

3. Provision of ample, well-designed, and easily accessible storage space.

4. The use of open planning, especially in small houses, in order to make small rooms seem larger.

5. Provision, wherever possible, of a place for such activities as games, music, dancing, shopwork, etc., where they will not disturb others in the family.

6. Provision for outdoor living, designed as part of the family living space.

7. Inclusion of sufficient insulation, vapor barriers, ventilation and heating and cooling equipment to provide comfort in both low and high temperature extremes.

8. Use of materials and equipment which will give long service at minimum maintenance expense.

9. The most logical uses and combinations of materials for the most livability with the least cost.

The Division's **Board of Architectural Review** is comprised of Thomas H. Creighton, Editor, Progressive Architecture; Talbot Hamlin, Professor of Architecture, School of Architecture, Columbia University; Douglas Haskell, Building Magazine; Philip Johnson, Chairman,

Quality House Program Requires Proper Materials, Skilled Workmanship, Distinctive Design.

Department of Architecture, Museum of Modern Art, and Frank Lopez, Senior Associate Editor, Architectural Record.

During 1950, Quality House projects were approved by the Institute and demonstration houses exhibited to the public in:

Phoenix, Arizona
Denver, Colorado
Hillsdale, New Jersey
Seattle, Washington (Projects No. 2 & No. 3)
Freeport, Long Island, New York
Waldwick, New Jersey
San Antonio, Texas (Four projects)
Cincinnati, Ohio
Flower Hill, Long Island, New York
Harrisburg, Pennsylvania
Glen Cove, Long Island, New York
Morristown, New Jersey

Contemporary Architecture Makes Efficient Use of Space, Provides Utmost Livability at Least Cost.

These educational exhibits serve two purposes; they acquaint the house-buying public with the fact that top quality is obtainable at moderate prices, and they also help to secure deserved recognition for the builders, manufacturers, architects, and other firms which cooperate to produce such quality houses.

In August of 1950, Crane Co. of Chicago joined with Revere Copper and Brass Incorporated of New York as a co-sponsor of the Quality House Program. The Institute is proud to have a second company of high standing in the industry as the first co-sponsor of the Quality House Program, and is confident that other reputable companies and organizations will find it to their advantage to join Revere and Crane in co-sponsorship during the next few months.

FIRE TECHNOLOGY DIVISION

A special research activity in fire technology was decided upon after many months of careful study over the nation and with the realization that much needs to be done in this field. It is recognized that the development of fire technology as a major phase of the institute's operations will require much time and effort, both in the fundamental and applied research phases, and that special facilities required must be carefully planned and provided for.

During the past year, particular attention was given to extensive literature investigations to develop the specific fields of research in which the Institute can most suitably engage. As a by-product of these surveys, a great mass of material suitable for bibliography purposes is developing. It has been decided to publish this material as a series of bibliographies relating to specific fields of industrial and public interest. The first such bibliography, on the subject of "Petroleum Industry Fires," has just appeared and two other bibliographies, one on the subject of "Dust Explosions" and the other on "Fire Resistant Materials," are in process.

These literature studies have revealed very little research activity in the use of acoustic energy in the extinguishment of fires; and accordingly, the division established a project in the Physics Department to determine possibilities. In preliminary work that has already been completed, it was noted that a surprisingly low power output is required to extinguish alcohol flames. This technique of fire extinguishment seems to be particularly promising in confined areas, such as in the nacelle of an aircraft engine where it is reasonable to suppose that acoustic power on the order of 100,000 watts could be made available for short periods to extinguish a large engine fire. Such an amount of power represents only a small fraction of the power output of a single aircraft engine, and the extraction of power from such an engine for purposes of fire extinguishment would not materially change the performance of the engine with regard to propulsion of the airplane.

During the year the division completed studies for the design of an advanced type of furnace for full scale evaluation of wall panels with respect to fire resistance; also completed was a design study of a facility to permit research and evaluation investigations on storage tank fires, and related fire prevention and protection equipment.

OCEANOGRAPHY AND METEOROLOGY DIVISION

This division was established at Southwest Research Institute because of the need for an independent institution to assist with the development of the Gulf of Mexico as a great natural resource. During the past year one of the principal activities of the division was the preparation of a report entitled "Program for Basic Analysis of Offshore Platform Requirements and Design" which was sponsored by the Offshore Operators' Committee, a group representing petroleum interests in the Gulf of Mexico. This report contains approximately 300 pages and includes, in addition to the material necessary to develop the program, two appendices with extensive data pertinent to the subject.

Preparation of this report involved numerous visits to those institutions throughout the country which possess laboratory equipment and facilities readily available to conduct phases of the program, and also to government agencies and possible sponsors to obtain up-to-date data concerning the solution of problems of a general nature.

The division has been working cooperatively with the American Institute of Radiation at Belmont, California, an organization which has been conducting exhaustive studies on fish reactions to various environments. In the past months, this program has progressed to the point where there is increasing promise of being able to "herd" and "ranch" fish in the future, and the division plans to extend this basic work into large water areas.

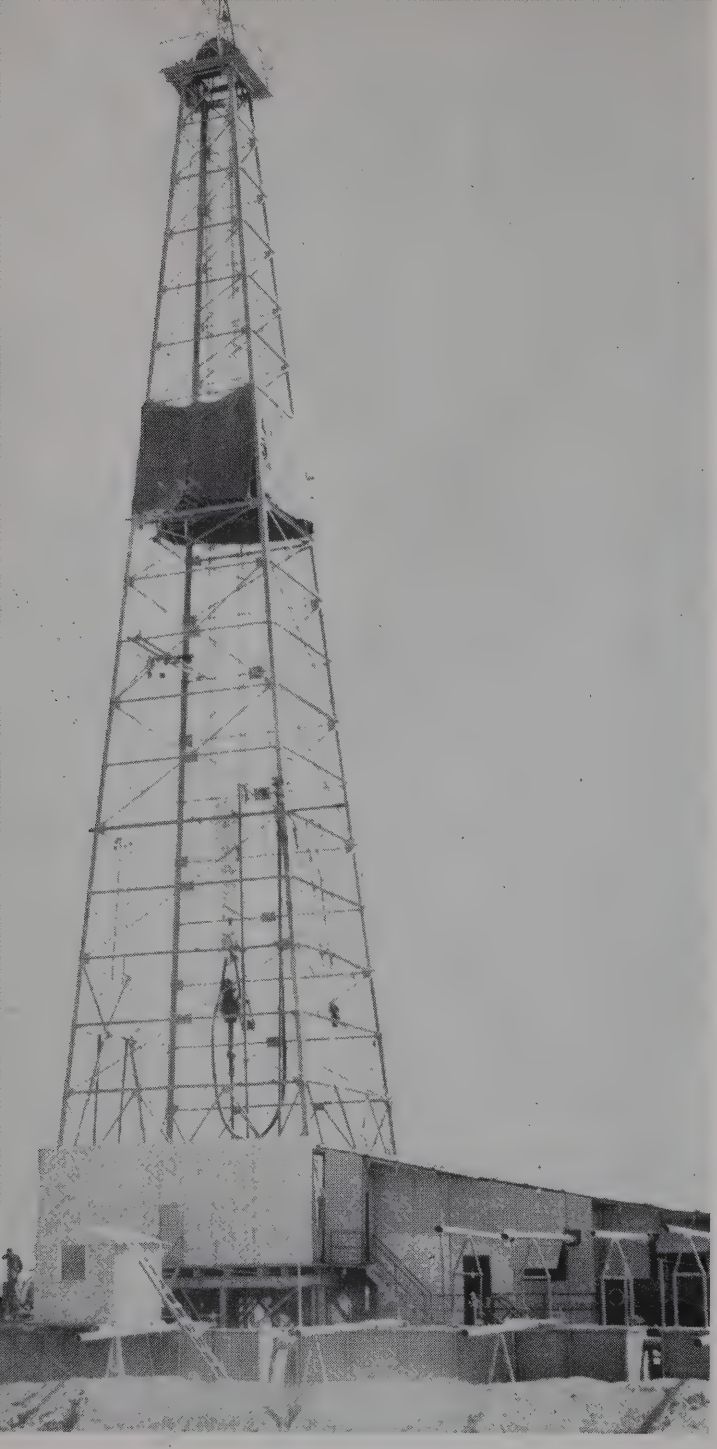
A development project is under way for the utilization of alginates in combination with hydrocarbons that result in "solid gasoline" pellets comprising approximately 96% gasoline and 4% alginate—a new form of non-explosive fuel. Alginates, produced from the sea, not only have extensive applications in our food industry, but are finding uses in other industries where they have advantage due to the peculiar characteristics of the material.

The effect of industrial wastes on fish and marine life is a major project that has been in progress for over a year and is sponsored by the Celanese Corporation of America. Already a great wealth of information has been developed on the effects of various types of chemical waste products on a variety of fish

types, and this material is being published from time to time. Other phases of the problem of industrial wastes and their effect on marine life, both in fresh and salt waters, are being studied.

Work being done for the petroleum industry is concerned with the effect of geophysical exploration methods on fish life, and a method is in process which has the promise of minimum harm to fish life, although it must be further proved that it has value as a geophysical exploration tool over water areas. The division distributed its first publication, entitled "Bibliography on Offshore Petroleum Developments," by Emory N. Kemler, during the year.

Schooner "Harpoon" —
Floating Oceanographic Laboratory.



PETROLEUM TECHNOLOGY DIVISION

This field of research and development activity is particularly well suited to the Institute because of its geographical location in the great Southwest petroleum production and refining area. The division is presently in its formative period and will coordinate the already substantial activities of the Institute's research departments in the fields of exploration, production, processing and end products.

Special attention is being given to reservoir engineering, with emphasis on primary and secondary recovery.

Research —
Exploration, Drilling,
Production, Distribution, Refining.

SPECIAL PROJECTS DIVISION

The Special Projects Division, created during the year, has the function of bringing together inventive ideas, the scientific and technical personnel to develop them, and an industrial organization active in the particular field of application.

Such an activity is unique among scientific research institutions. The successful application of this technique depends largely upon the flow of novel ideas from all over the world into the Institute of Inventive Research, an affiliate of SwRI, and also the subsequent interaction of these ideas in the minds of the scientific staffs of Southwest Research Institute and the Foundation of Applied Research, also a separate, but affiliated, organization.

While companies have in the past expanded by the outright purchase of patents or completely developed items, many of these firms would prefer to collaborate in the perfection of a product, process or technique at an earlier point in its development. By this means their own staff participates in the production know-how, and the final product fits more closely their particular manufacturing and plant conditions.

The division coordinates a review and appraisal by appropriate technical personnel of a wide variety of new suggestions for products and processes, and if indications are favorable, informs companies in the particular field concerning the known potentialities of the new idea. If an interested firm concurs that the idea merits further study and wishes to sponsor its development, Southwest works closely with the manufacturer's organization in the required research.

An industrial concern thus becomes a partner in what is essentially a venture-capital enterprise, and for this element of risk the sponsoring company is allotted special consideration in any patents which may issue, or obtains a several-times direct return on research funds invested.

Among the promising new ideas now available for such a collaborative development program are: a method for the electrodeposition of aluminum on other metals; a milk bottle stenciling machine; a circular weaving loom; an antioxidant for the preservation of lard, fats and oils from a little-used native fruit; a high speed mechanical casting machine; certain chemical applications of carbon dioxide; several oil field equipment devices; a bus fare meter, and a pelletizing machine.

INTERNATIONAL DIVISION

It has long been realized that science and technology do not recognize geographical boundaries and that an institution which serves in the international field can be of great benefit not only to the country involved, but can develop a pool of valuable experience in the utilization of natural resources the world over that benefits development at home.

It is for this reason that the Institute has, since its founding three years ago, had a specific objective of service in the international field, but it was just during the past year that this program was initiated. Members of the staff had already had experience in numerous other countries of the world, including Argentina, Mexico, Germany, France, and the Scandinavian countries, in association with research groups.

Recognizing our nation's foreign policy in making technological skills available to friendly nations as a policy that was not only one of long range consideration but one that was being expanded materially through such agencies as the International Bank for Reconstruction and Development, the Economic Cooperation Administration, and the Point Four Program, and realizing that a number of other American institutions were equally interested in foreign service of this character, Southwest Research Institute joined with Armour Research Foundation and Stanford Research Institute on an informal basis to pool their staff and facilities so as to be of maximum effectiveness abroad and at the same time enable strengthening of activities at home. Southwest was given a contract by the International Bank for Reconstruction and Development to provide scientific personnel for the Francis Adams Truslow mission to Cuba. Both Armour Research Foundation and Stanford Research Institute joined with Southwest in providing personnel involved so that highly qualified experts in the fields of agriculture and industry, transportation and economics were made available. The work of the mission began in July and will be completed about the end of the year.

The three institutions have also been asked by other agencies for the development of "research teams" to go to other countries of the world, and these programs are presently under negotiation.

During the year, Southwest Research Institute

Flag Arcade on Laboratory Grounds Flies Colors of Southwestern States and Countries SwRI Serves.

was asked by the Institute of Technology of Monterrey, Mexico, to assist in the establishment of a research service program in Mexico, and a new research institution operating at the Institute of Technology at Monterrey will be initiated about the first of next year as an affiliate of Southwest Research Institute. This procedure will enable the use of the joint facilities of Southwest and those of the new institute in Monterrey for service in Mexico, both to local and to domestic organizations interested in Mexico.

RESEARCH DEPARTMENTS

The research departments of the Institute conduct all laboratory and field investigations, whether these be on fundamental programs sponsored by outside groups or from Institute funds, or on applied projects supported by industry, government agencies, associations, manufacturers, and similar organizations.

The Institute conducts its work in the degree of confidence required by a sponsor and any patentable results become the property of the sponsor.

During the year, 49 new research projects were undertaken and work continued on 21 carried over from the second fiscal year of operation. In addition, 64 relatively short term special investigations were concluded during the year.

Progress which can be announced on research projects under way in the various research departments during the year follows:

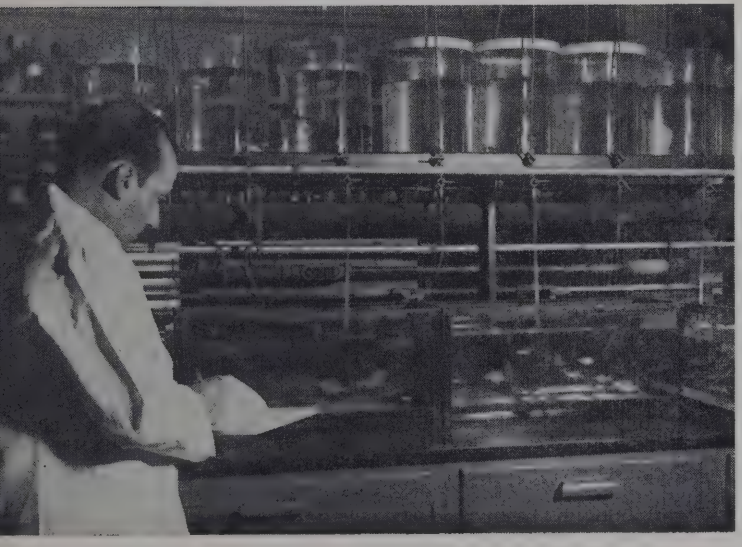
AGRICULTURE AND CHEMISTRY DEPARTMENTS

INDUSTRIAL WASTE TREATMENT AND DISPOSAL. The Institute is becoming highly specialized in this field through increasing activity and experience. Presently there are four separate organizations supporting work of this character at the Institute. Of particular note is the special major program for the Celanese Corporation of America which is continuing into its third year. The waste treatment and disposal problems of the Company's large plant at Bishop, Texas are extremely difficult and typical of other industrial operations throughout the semi-arid area where there is completely inadequate dilution water available. The whole approach to this problem has been a careful analysis of the character and origin of the wastes, and the separation of the wastes into two categories—those that can be discharged without treatment and those that must be treated. Because these latter wastes are toxic to aquatic life, unique methods for their treatment to meet special local conditions are being developed and already substantial improvement has been made. One of the unique phases of the program has been the development of new techniques as illustrated by the use of various species of fish as indices of pollution. Special publications on this program will issue shortly.

PLASTIC CONTAINERS. An investigation was concluded to develop flexible, cheap, lightweight plastic containers, especially for materials which might need to be sterilized, the use of which would greatly reduce the cost of packing and transportation. A number of available plastic materials were fabricated into inexpensive containers of a variety of shapes and a method developed for removing contents without air entrance.

BANANA WASTE PRODUCTS. An investigation was made for the Monterrey Metal and Iron Company to determine possible means of using banana stalks in industry. A complete bibliography covering the subject was prepared and a number of recommendations were made with respect to use of this material in industries that could be established without a high capital investment.

Industrial Waste Treatment and Disposal.



Brush Control — Examining Roots for Solution Sprayed on Leaves.

BRUSH KILLERS. A study was conducted for the Stull Chemicals, Inc., the objective of which was to definitely establish the translocation of brush killers applied to the leaves or trunks of trees. Radioactive Iodine 131 was added to a chemical brush killer. This radioactive brush killer was then applied to the leaves and trunk of mesquite and other brush. The movement of the radioactive brush killer within the tree was then traced with a Geiger counter. It was found that the radioactive material apparently moved down through the phloem and was distributed into the root system.

PAINT AND LACQUER EVALUATION. Petroleos Mexicanos sponsored work in the evaluation and the development of paints and lacquers. Their purpose was to provide for the Mexican market high grade paints and lacquers of proven quality and efficiency. A number of their products were tested and compared with products of standard quality and recommendations were made which would enable them to continue marketing good paints and lacquers.

FLUOROSIS IN CATTLE. The Victor Chemical Works is sponsoring an investigation, the purpose of which is to obtain more information on the physiological role of fluorine in cattle nutrition. The experiments which were conducted in Tennessee included a clinical examination of cattle and a laboratory study of their bones and tissues under various conditions of fluorine intake. Although the results of this study have not been completed, a great deal of information has been assembled which will contribute to the ultimate solution of the problem.

OIL TESTING. The Chemistry section of the Institute works in conjunction with the Engine Laboratory which is set up to evaluate fuels and lubricants. Modern equipment is available for the various chemical and physical determinations that are required of the new and used lubricants. The results of these determinations when combined with the findings of the Engine Laboratory provide adequate information for the evaluation of the lubricants and the development of new and better products in the field. The number and type of determinations that are performed vary according to the particular type of study that the Engine Laboratory has under consideration. When new or unusual determinations are required, the latest available equipment is obtained or developed so that a "modern" laboratory is maintained at all times.

BORON IN IRRIGATION WATER. An investigation is under way to develop a method for economically removing boron, which is injurious to plant growth, from irrigation water. While traces of boron are essential for some plant growth, concentrations as low as 1 ppm may be detrimental to citrus; cotton, one of the more resistant crops, can tolerate 4 ppm or less. The water under test contains slightly more than 4 ppm boron as do some new and potential sources of irrigation water in the lower Rio Grande Valley. Removal of boron from this and other waters in the Valley would enable agricultural production to expand considerably. Thus far in this study, several new methods of removing boron have been developed; however, further work will have to be done to render them economical processes.

INSECTICIDE CONTAMINATION. Samples of insecticides used for the controlling of cotton insects were submitted to the laboratory. These insecticides were suspected of being contaminated with 2, 4-D (weed killer). Bio-assays were made on these insecticides by spraying various dilutions of the insecticide upon the growing tips of papaya plants. Within seven to ten days, the 2, 4-D effect could be easily noted on those plants sprayed with an insecticide in which 2, 4-D was present. Known dilutions of 2, 4-D in water were made up and applied to some other plants for comparative purposes. Cotton plants sprayed at the same time did not show the 2, 4-D effect until after twenty-one days.

SPANISH MOSS. A search for an improved method for the retting of Spanish moss was made. Fungi, bacteria, inorganic chemicals and enzymes were used in this study.

KENAF FIBER. The objective of this project, sponsored by Rio Farms, Inc., is to correlate existing information now available on Kenaf production and determine if this plant can be grown as a crop in South Texas for fiber production. Plots of the Kenaf fiber were grown on the laboratory grounds. Time of planting and flowering dates for seed production were determined. Portions

Crude Oil, Fuels, Lubricants Analysis and Evaluation.

of some of the plots were cut and stems were decorticated. The per cent of fibers was calculated and the quality studied. An insect and disease study of Kenaf was also made. All information is correlated with plots grown at Rio Farms.

TRIDINE. The purpose of this study, undertaken by a grant from Clairmint Chemical Company, is to determine the therapeutic value of Tridine in the treatment of mycotic (fungus) infections, the amount of this therapeutic agent to be administered, and its comparative toxicity with that of iodine. Thru the cooperation of clinicians, a total of 51 patients received therapeutic doses of Tridine over the past year. Some of the results obtained were very encouraging.

FLOUR INFESTATION. Flour weevil eggs were exposed to radioactive Cobalt 60 in order to determine if the gamma rays have a lethal effect upon the grain weevil eggs. Eggs are in the process of incubation.

WOOL STUDIES. A project was conducted for the Institute of Inventive Research designed to study the application to loose or sheared wool the process used in plasticizing pelts and producing moutons. This is a method developed for plasticizing sheep skins causing the hair to remain straight and giving it a glossy appearance. The wool so treated would have a much wider application of uses; shrinkage would be reduced and the product would have a silk-like property. This study was carried on in cooperation with a local tannery and woolen mill. The wool was treated and then processed into cloth and a study made on its shrinkage reduction.

SNAKE VENOM STUDIES. Pooled venom from western diamondback rattlesnakes was obtained and experiments were conducted to determine maximum tolerated dosages of a special chemical substance in animals, looking forward to the eventual application of this material in human medicine if the product showed activity. The experiments were conducted over a period of several months.

SPECIAL ANALYSES. The Institute has developed unusual facilities for the handling of special analytical problems. Normal analytical work is directed to commercial laboratories, but where unique information, in the course of basic research, is required with precise accuracy, necessary techniques are developed and used by the Institute.

RANGE MANAGEMENT. The Institute is establishing a Range Management section to meet the tremendous demand for services in range research and improvement throughout the Southwest territory, as well as in foreign countries. It has already been noted that cattle carrying capacity on ranges in many parts of semi-arid regions can be increased three to four-fold by utilization of proper fertilizers, grasses and brush control. In this connection, the 4,000 acre Essar Ranch, which is the agricultural research facility of the Institute, has already been used extensively and several publications on this general activity have already issued.

CITRUS RESEARCH. Approximately one year ago the Texas Citrus Commission was created by the State Legislature. The Commission operates on funds derived from a tax on citrus production in the Rio Grande Valley and utilizes this income for research and the development of consumer use of the products. The Institute was selected by the Research Committee of the Commission to coordinate all research activities, with Dr. C. L. Shrewsbury of the staff as Research Director. Major research programs are being established in several Texas institutions. These projects are directed toward better soil conditions, improved quality, higher yields, disease control and new end products and by-products.

CHEMICAL ENGINEERING DEPARTMENT

THE CARBUROLITH PROCESS. The Carburolith Process is a method of preparing liquids in solid pellet form or in capsule form. The liquid is easily recoverable and constitutes up to 98% of the pellet or capsule. Two types of pellets have been developed—the "solidified" type, the body of which is a cellular structure; and the capsule type, which has a thin, tough skin around the pure contents. Processes for mass-producing both types have also been developed. A large laboratory apparatus with a capacity of 25,000 pellets per hour is in operation and a pilot plant is near completion. The process has been applied to several types of oils, gasoline, perfume, insect repellents, etc. It is expected to find application where it is desirable to handle liquids in solid form at low cost, or where liquids or emulsions are distributed or used in small individual quantities. The sponsor has made the process available for licensing on a uniform basis.

NEW USES FOR HYPERMATIC MATERIALS. Under the sponsorship of Rockwell Manufacturing Company, the characteristics and properties of several existing compressible gas-liquid dispersion materials were determined and a fundamental study made of their constitution. From this analysis, it was possible to estimate the limits of such variables as degree of dispersion, viscosity, etc., and from these ranges, it was possible to estimate the limits of its behavior as to its several unique properties. Thus, a wide search for applications for this type of material could be made without incurring the expense of preparation of a wide assortment of materials, uses for the majority of which probably would not exist.

NEW PRODUCTS FROM LUBRICATING OIL EXTRACTS. This study, sponsored by a major oil company, has involved a study of both the physical and chemical properties of these extracts combined with a methodical screening of possible applications. Two very interesting volume uses have been found.

USES FOR ETHANE AND PROPANE. These two raw materials are available at each of several locations in quantities of the order of a million pounds a day at a fraction of a cent a pound. This fundamental study consisted of a methodical screening of the various chemicals that could be made from them. Those chemicals which survived the screenings were studied as to plant cost and investment return for various plant capacities and alternate processes, and the results reported in graph form. A cost-estimating procedure was followed which enabled completion of this study at very reasonable cost.

MIRROR-MAKING PROCESS. A rapid method of producing mirrors was critically examined as to the fundamental processes involved. The several operational difficulties which existed were overcome, and the life of the silvering was increased tenfold as indicated by accelerated tests in the salt-spray chamber.

PORTLAND CEMENT FOR OIL WELLS. Under the joint sponsorship of Longhorn Portland Cement Company and Halliburton Oil Well Cementing Company, the special requirements of cements in oil wells were determined, and methods of meeting them are being developed.

ROCK WOOL BINDERS (Foreign Sponsor). A satisfactory low-cost binder was developed which could be made largely from domestic materials. A careful study showed that available binders greatly exceed certain requirements while barely meeting others. As a result, a binder containing a large amount of an inexpensive ingredient was perfected.

ASBESTOS SHINGLE EFFLORESCENCE. The pigment in the colored veneer on these shingles has a tendency to drift to the edges where a "picture-frame" appearance develops, and the surface takes on a faded appearance. A fundamental study of the forces acting upon pigment particles was made. This analysis of forces made possible the specification of several alternate means of nullifying them at negligible cost. These treatments produce a stable and brighter color.

BRIGHTNESS IMPROVEMENT OF WHITE ASBESTOS SHINGLES. A series of sample veneer coatings were prepared in the laboratory in which the ingredients were varied within the limits which would be commercially feasible, and the whiteness of each was measured in a reflectometer. A judicious selection of sample compositions in this series made possible the recognition of the source of dullness in the color, and a test of a series of samples revealed means for gaining brilliance.

LUBE OIL ADDITIVE. Work in this highly specialized field is greatly facilitated by the existence of the excellent Engine Laboratory in this Institution, and of men on the staff with familiarity with the available additives, the patent literature, and the objectives of additives. A chemical manufacturer has sponsored the development of a very promising additive from a widely available raw material.

WAX REFINING (Chemical). A domestic wax available in quantity has been examined to determine the possibility of inexpensive chemical treatments for its refinement. This study has been encouraging, and the evaluation of these methods is being made in glass apparatus.

PRE-PERMANENT HAIR RECONDITIONER. A cosmetic manufacturer sponsored this project for the development of a material for application to the hair just prior to the permanent-wave treatment, the objective of which is to minimize the effect of a former wave so that the new wave could be applied with less difficulty.

UNREFRIGERATED PECAN STORAGE. The storage of pecans is one of suppressing rancidity and color degradation, and present practice is by means of refrigeration. The Southern Pecan Shelling Company sponsored a project for the development of an economical method for the storage of pecans at ambient temperature. This involved a fundamental study of the low-rate chemical reactions that were involved within the pecan meats and the planning of a low-cost procedure for suppressing these reactions without refrigeration. Two successful procedures were found.

BRICK VENEER WATER LEAKAGE. Three simulated brick veneer walls were built, one using Inner-Lox type brick, and the other two using similar common brick. The amount of water seeping through the wall as a result of simulated rain upon the opposite side was measured. The Inner-Lox brick did not leak, but the common brick, under certain conditions, leaked 20 ounces per hour per square.

REFRIGERANT. The specific heat at constant pressure of a recently developed, nationally advertised air conditioning refrigerant was accurately measured in a dynamic system. The system was carefully designed after analyzing the sources of errors and means for minimizing them. The results were reported as a breakdown of the small error that remained, and a set of well-agreeing data points.

WATERPROOFING EFFECTIVENESS. Burney and Felder, manufacturers of stone facings, sponsored a project for the measurement of the effectiveness of waterproofing treatments on stone facing. Special cells were prepared for measuring the permeability of the treated and untreated stone specimens. These measurements showed that the treated stone specimens did not permit the passage of water at pressures equivalent to wind velocities of over 100 miles per hour.

WEATHERING TESTS OF BUILDING MATERIALS. Several manufacturers have sponsored weathering tests

Specially Designed Pilot Plant Constructed by Chemical Engineering Department.

Specially Built Wall for Permeability Studies.

consisting of wetting and drying cycles, freezing and thawing cycles, and fading treatments to determine the durability and estimated life of facing materials. Such cycles are planned after a fundamental study of the rate of temperature change of humidification, etc. Twenty to thirty cycles have been considered to be sufficient.

INSULATING VALUE. The heat transfer coefficient of several building materials has been carried out. A method for proportioning the dimensions of the sample and the other variables in the test are used in order to get maximum accuracy within a reasonable time and reasonable cost.

FATTY ACID PLANT. In the refining of vegetable oil, the conversion of the resulting soap stock into fatty acids changes a troublesome waste into a marketable product. Being an almost profitless by-product operation, it is undesirable to invest in expensive designs and equipment. The process was worked out using the sponsor's materials and was planned in such a way that his organization could complete the engineering and construction. It was necessary that the plant use certain pieces of equipment and materials which were on hand. Another requirement was a metering device for continually neutralizing the waste water in a manner necessary to make it acceptable by the city disposal plant.

TANNIN EXTRACTION PLANT. This project included a plant-site study consisting of a balance between transportation costs and plant operating costs. This part of the work was reported in the form of curves showing total production cost versus plant capacity in several assumed locations. With this indication as to the plant capacity that was of interest, the preferred type of

equipment was selected and a pilot model built for testing and product evaluation. These data from this study were needed for the design of the equipment for the tannin extraction plant. Product quality has been an important factor in all of this work.

TECHNICAL SERVICES. Companies who rely on the Institute for their research and other technical services occasionally require careful scientific studies to be made, some of them at the site of their operations. The broad experience of a diversified staff makes possible the rapid and realistic evaluation or resolution of technical problems or developments which arise. Typical of these was an examination of the equipment and the engineering in the design of the Upton Gas Products Company's Benedum Plant.

COHUNE NUT SHELLER. The kernels of these nuts have a ready and insatiable market at a price equal to that of Copra (of the order of $250.00 per ton), and the nuts are widely available at a collection cost of $2.50 per ton. A ten per cent yield leaves a gross difference of $225.00 per ton of meats, most of which is available for the shelling operation. The sponsor himself spent several months in Central America studying the opportunities, operating problems, supply, etc., and engaged the Institute to develop a method and a machine which would operate within the required limitations. As a result, a machine weighing less than 1,000 pounds has been developed for shelling six nuts per second which is $200,000 worth of meats per year.

COATINGS. Numerous projects requiring the development of coatings have been successfully completed. The key to this has been the considerable background of several staff members in the compounding of plastics, requirements of plasticizers, experience in diffusion through plastic films, etc. Typical of these projects are the development of parting materials for precast concrete members, development of plasticizers, compounding and evaluation of coatings, evaluation and development of waterproofing materials, and various other studies in surface chemistry.

DOMESTIC DRINKING WATER FLUORINATOR. The problem of introducing one part per million of fluorine into a small stream of water by a fixture of reasonable size attached to a water faucet is a challenge to the best physical chemists. The problem has been analyzed, the form it must take determined, and a method and material developed for carrying out the operation. A patent search has shown that it is patentable and further development of the material is in progress. The sponsor plans to turn this over to a manufacturer when completed.

CONTINUOUS FERTILIZER INJECTOR. It has been found that liquids injected a foot or so underground fracture the soil horizontally and spread several feet. Using this principle, a machine which operates without stopping has been designed which will rapidly penetrate and inject liquid at the rate of 100 gallons per minute. Numerous features of this work were found to be novel.

PROPANE AND ETHANE RECOVERY PROCESS. A new low temperature process for the recovery of these important raw materials has been developed which operates at high efficiency and uses simple, inexpensive equipment. It is capable of unattended operation, and sizes up to 10 MMcfd or larger are portable.

UNSWEETENED TEA CONCENTRATE. A new unsweetened liquid tea concentrate has been developed as a result of a fundamental study of the chemistry of tea. The retention of the tea flavor is excellent.

EXPLOSIBILITY LIMITS OF FOGGED INSECTICIDE. The approach to this problem was by means of a special burner in which the oxygen content of the supporting combustion air could be varied above and below 20 per cent. Several factors expected to influence the explosibility limits are to be studied, and their combustion limits in terms of minimum oxygen requirement will be plotted to show the danger area or the magnitude of the factors of safety of the various compositions. It is expected that a special ingredient will considerably reduce the ability of the fog to propagate a flame.

PUMPKIN SEED SHELLER. A commercially feasible method for recovering the meats from imported or domestically grown pumpkin seed has been developed, and an automatic machine for shelling the seed at a high rate has been designed and built. These meats are sold nationally in the oil-cooked and salted condition.

ENGINEERING MECHANICS DEPARTMENT

FLUTTER INVESTIGATIONS. A project in wing flutter is being carried out under the sponsorship of the Air Materiel Command of the U. S. Air Force. Wind tunnel models are being made which are dynamically and structurally similar to the wings of typical modern high-speed aircraft having unconventional planforms. Actual flutter speeds will be measured in a wind tunnel and analysis carried out, using the best available theoretical methods, in order to compare calculated and measured flutter characteristics.

"CONCRETE SLAB FOUNDATIONS. This project seeks to develop design criteria for concrete slab foundations for houses when built on unstable soils frequently encountered in the Southwestern States. It is being sponsored by the Housing and Home Finance Agency of the Federal Government. Based on a survey of existing literature and practice, scale models of promising types of slabs are being laboratory tested for stress and deflection for the purpose of developing more economical designs. These include, as a control, a slab and girder design which is acceptable to the San Antonio Insuring Office of the Federal Housing Administration. An attempt is also being made to develop a reliable apparatus and test procedure for testing the activity of colloidal soils so that the expense of special foundations may be eliminated except where these active soils are present."

TEXTBOOK PREPARATION. The U. S. Army authorized the preparation of a textbook to be used for the fundamental instruction of soldiers in the basic construction and functioning of weapons. This work required preparation of the entire textual material and also the photographs and line illustrations, all of which work was performed by Institute personnel.

AUTOMOBILE AIR CONDITIONING. A survey and study directed at the possibility of air conditioning automobiles has been sponsored by a large eastern automotive accessory manufacturer. This study showed that there are definite possibilities for the large scale manufacture of a novel type system which could be built and installed at a considerably lower cost than the units presently available.

MASONRY CORE DRILL. Work has been completed on the design, construction, and commercial application of a horizontal portable masonry core drill. This program called for the development of a core drill which would use air as a circulating medium and which would allow no dust from the cutting operation to escape. Work has recently been completed on an air conditioning job wherein 260 five-inch diameter holes were drilled through 14 inches of masonry wall at a total cost of $5.62 per hole. This cost is approximately 15 per cent of that estimated by the subcontractor to drill these holes in the usual manner.

COTTON COMPRESSION STUDY. Work sponsored by the National Cotton Compress and Cotton Warehouse Association has included a study of the present cotton compress methods and has been directed at the possibilities of replacing many of the manual operations by automatic equipment. This study has shown that the application of modern material-handling methods, and machinery to the cotton compress industry has definite possibilities to reduce greatly the cost per bale in compressing cotton for export.

NEW FARM MACHINERY. A project was sponsored by Rio Farms, Inc., for the design and construction of a tractor-drawn conveyor to reduce labor in harvesting such crops as lettuce and cabbage. This piece of equipment was designed and constructed by the Institute. It is now in use in the Rio Grande Valley and is proving to be a substantial labor saving device.

BASSSINGER DRILL. Work on a new drilling technique which adds impact energy to conventional rotary oil well drilling practice has been under way for the past two years. This work has been sponsored jointly by the Institute of Inventive Research, the Hewgley Drilling Company, and the Bassinger Tool Company. Rotary percussion drills in several sizes have been designed, constructed, and field tested and are now in commercial use. This rotary percussion drill, under many drilling conditions, has made outstanding records both in rate of penetration and total footage per bit as compared to the conventional method.

NEW DEVELOPMENT IN AIR TOOLS. A west coast company is sponsoring a research program directed at the increased life and decreased cost of air tools used in the construction industry. Recent tests have shown this development to have reached a very successful conclusion, and patent applications are being prepared to be assigned to the sponsor.

NEW BUILDING TECHNIQUE. On a program sponsored by the Institute of Inventive Research work has continued in the design, development, and testing of equipment to lift concrete roof and floor slabs by the Youtz-Slick Lift-Slab Method of building construction which is rapidly being commercialized. This building method requires lifting heavy loads on from 4 to 16 columns and requires rate of rise control between lifting stations with positive means to prevent any retrograde movement.

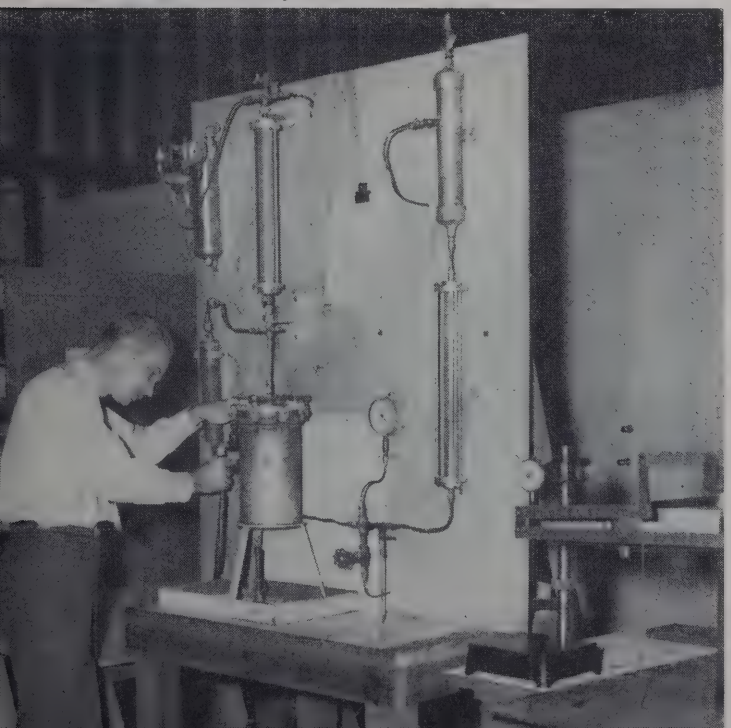
In the Youtz-Slick method for reinforced concrete construction, a concrete foundation slab is poured, finished, and covered with a separating medium. The next higher slab is poured directly on top of the foundation slab. Steel collars surrounding the columns are included in the above-ground slabs. When these slabs have set to strength, lifting equipment is moved onto the job, and the above-ground slabs are lifted to their permanent position and welded in place.

In the early stages of development, the Institute was faced with the problem of designing and constructing equipment to lift and accurately control concrete slabs in which the load carried per column might be 100,000 pounds and the number of columns as high as sixteen. This meant that the equipment must handle a single slab weighing 1,600,000 pounds or 800 tons.

General specifications were written, and these specifications were directed principally at safety of operation, ease of transportation, minimum labor cost, and speed in erection.

The results have been the successful development of equipment which has recently been used to construct a two-story building 356 feet long by 73 feet wide. This method saved a substantial sum on this first commercial application. The lifting equipment performed perfectly on this job in raising 14 slabs to their final position. The heaviest slab was a flat slab 10 inches thick, weighing 378,000 pounds, which was lifted on eight columns. All of the specifications as originally set forth for the lifting equipment were proved, on this job, to have been fully met.

Volume Meter Measures Density Changes in Soil Stabilization Project.



SERVICE STATION DESIGN. Continental Oil Company initiated a research program to determine the space requirements of service stations in order that future construction would afford space and facilities required in a modern station. After a perusal and evaluation of their completed study, the Institute of Inventive Research outlined a program of further research for adapting the Youtz-Slick Lift Method to the design characteristics required to fulfill the functions of a service station. This exploratory program was accepted by Continental Oil Company on February 28, 1950.

Four test stations have been designed for varied locations so that a cross section of public acceptance and construction adaptability might be obtained. It is believed that a fresh approach might result in an eye-appealing and easily-maintained station meeting all operational requirements of a contemporary service station.

AUTOMOTIVE LABORATORY

FUEL AND LUBRICANT STUDIES. The Engine Research Laboratory has completed another year of service to the petroleum, petroleum chemical, and automotive industries in the development and evaluation of motor fuels and lubricants. Functioning generally in activities related to mutual adaptation of engines, fuels, and lubricants, the laboratory has served fourteen major petroleum companies and six chemical additive manufacturers during the year. Of primary concern was the determination of suitability of several high additive content lubricants compounded for engine protection under conditions of high engine output and use of high sulfur fuels. Studies of ability of engine and lubricant to digest fuel contamination and fuel combustion products was continued, and the effect of high boiling range olefinic compounds in motor fuel was determined under conditions of low temperature operation.

Road octane studies related to change in apparent octane requirement of vehicles were carried out to evaluate effect of combustion chamber deposits and valve condition on motor fuel performance.

Several unorthodox motor fuels were investigated with respect to specific fuel consumption, combustion chamber deposition, and knock-limited engine performance.

The effect of certain lubricating oil filtering media on rate of oil oxidation and copper-lead bearing corrosion was the subject of an investigation formulated to develop fundamental design criteria and application data for vehicular use.

Liquefied petroleum gas utilization in internal combustion engines was studied from the standpoint of service performance and engine changes necessary to assure effective use of the inherent advantages of L.P.G., particularly propane.

Future plans for the Engine Research Laboratory include the installation of Buda model 1-BD single-cylinder diesel engines for detergency studies of lubricating oils and deposit forming studies of fuels, and an Electromotive model 2-567B railroad diesel test engine for fuel, lubricant, and mechanical component research, development and evaluation. This latter engine will be a cooperative venture sponsored by six companies who will share the equipment and installation expense and participate equally in the use of the facility.

AIRCRAFT FUEL AND LUBRICANT RESEARCH. The installation of a Waukesha C.U.E. crankcase is being completed and will accommodate most of the standard aircraft engine cylinder barrels. The facility will be available for fuel and lubricant research and development.

A unique research and evaluation tool has been provided in the form of a fleet of freight aircraft operating on scheduled flights, which can be used to develop service performance data on aircraft fuels, lubricants and components. Repetitive operations assure complete control of evaluation procedures. Complete service and repair facilities are available, and run-in cells, prop-stands, and a mobile testing station are included in the facility.

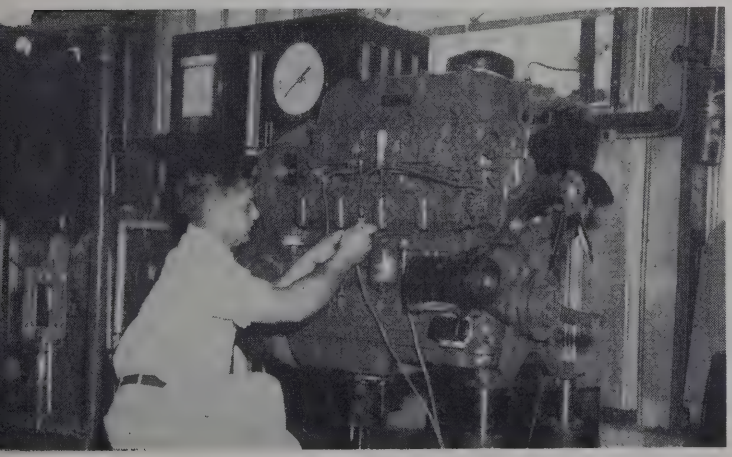
SERVICE EVALUATION OF PETROLEUM PRODUCTS. During the year an extensive road evaluation program was completed for The Texas Company on several petroleum products to provide its research staff with actual service performance data obtained under controlled conditions, simulating customer high-speed driving under high-temperature ambients. Products studied included a crankcase motor oil fortified with oxidation inhibitor and detergent to provide optimum oxidation stability and minimum deposit forming tendencies. Also studied were several experimental and proposed production products, such as hypoid gear lubricants, automatic transmission fluids, and wheel bearing greases. A total of fourteen vehicles were operated a distance of 20,000 miles each to develop the required evaluation data.

The Standard Oil Company (Indiana) sponsored a comprehensive road evaluation study of a petroleum product to supplement findings of their Automotive Laboratory, wherein dynamometer studies had been conducted to develop fundamental criteria for the performance of the product. Used, post-war automobiles driven under simulated average "commuting" motorist conditions provided the factual data for the study.

ORDNANCE LUBRICANTS. Re-refined motor oils were subjected to oxidation resistance and detergency studies to determine their suitability for use in U. S. Army ground vehicles. The re-refined product was compounded with chemical additive to replace natural and added inhibitors removed both through previous usage and in re-refining process. Findings will supplement technical and economic studies made by Department of Defense on use of re-refined motor oils.

TIRE TREAD WEAR RESEARCH. For many years highways in the San Antonio neighborhood have been utilized by the major tire manufacturers for road evaluation of passenger car and truck tires to provide service performance data useful in the preparation of economical tires of satisfactory life. Compounding characteristics of the natural and synthetic rubber components, selection of anti-oxidants and plasticizers, determination of fabric flexure strength and bonding characteristics, and construction details have been widely confirmed and studied by means of road work supplemented with extensive laboratory studies. The Institute's Automotive Road Evaluation Laboratory carried on such an investigation to establish predicted tire life under normal tire inflation conditions but with high loading. Growth of tread cuts was measured after initial deliberate tread cuts, to determine resistance to rubber separation and tread damage. Carcass fracture tendencies were further explored in the laboratory.

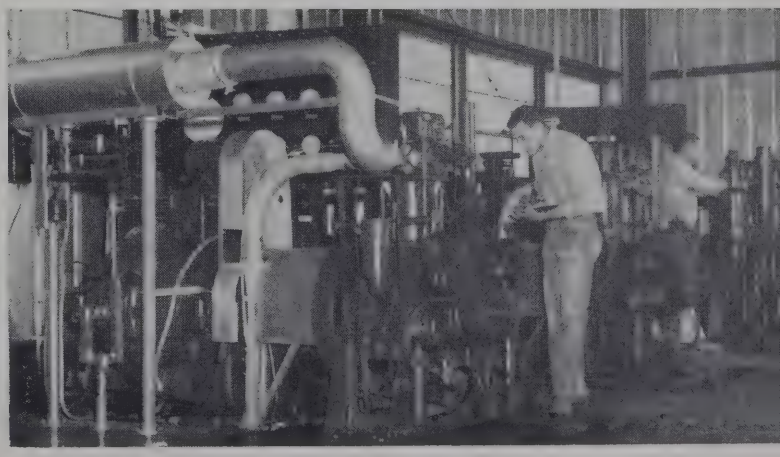
Diesel Engine Undergoing Performance and Durability Studies in Continuous, Cyclic Operation.



MILITARY ENGINE EVALUATION. A study of performance of several small light-weight, high-speed, two-cycle gasoline engines was completed during the year. Objective of this study was to determine endurance characteristics as influenced by use of Army specification fuels and lubricants. Incidence of spark plug fouling and valve port plugging was determined to establish possible service difficulties when using minimum quality motor fuel meeting prevailing specification. Final report included comprehensive analysis of mechanical component performance, torsional vibration problems associated with application to driven members, fuel and lubricant tolerance, effects of pre-ignition and detonation, and mutual adaptation characteristics of engines with fuels and lubricants.

During the year a second evaluation program was begun for this sponsor, Engineer Research and Development Laboratories at Fort Belvoir, on an experimental diesel engine of high-speed, two-cycle unaflow type. Endurance characteristics under both cycling and sustained high load conditions are to be studied. Again, fuel and lubricant tolerance will be an integral part of the investigation. Diesel fuel of 1% sulfur content will be used to determine deposit and wear characteristics as related to the use of high sulfur fuels. Comprehensive evaluation of this power plant as a general purpose military engine is planned.

Research Engines for Development and Evaluation of Lubricants and Additives.



MINERAL TECHNOLOGY DEPARTMENT

The Mineral Technology Department was created in May, 1949 to aid in the exploitation and development of the mineral wealth of the Southwest and to give technical service, nationally and internationally, in mineral technology. Since its inception, the department has taken a very active part in contributing fundamental knowledge of the properties, occurrences and industrial uses of mineral resources in various parts of the Western Hemisphere. A steadily increasing demand for fundamental investigations by the group in all fields of mineral technology has resulted in an increase in the number of its technical personnel and a constantly growing inventory of equipment.

A primary function of the department is the study and survey of the techno-economic aspects of mineral deposits and to determine the character, quality and geographical location of such deposits. It also develops methods for the utilization of minerals as raw materials for industry and evaluates and analyzes the available markets and processing incentives for raw materials and manufactured mineral products.

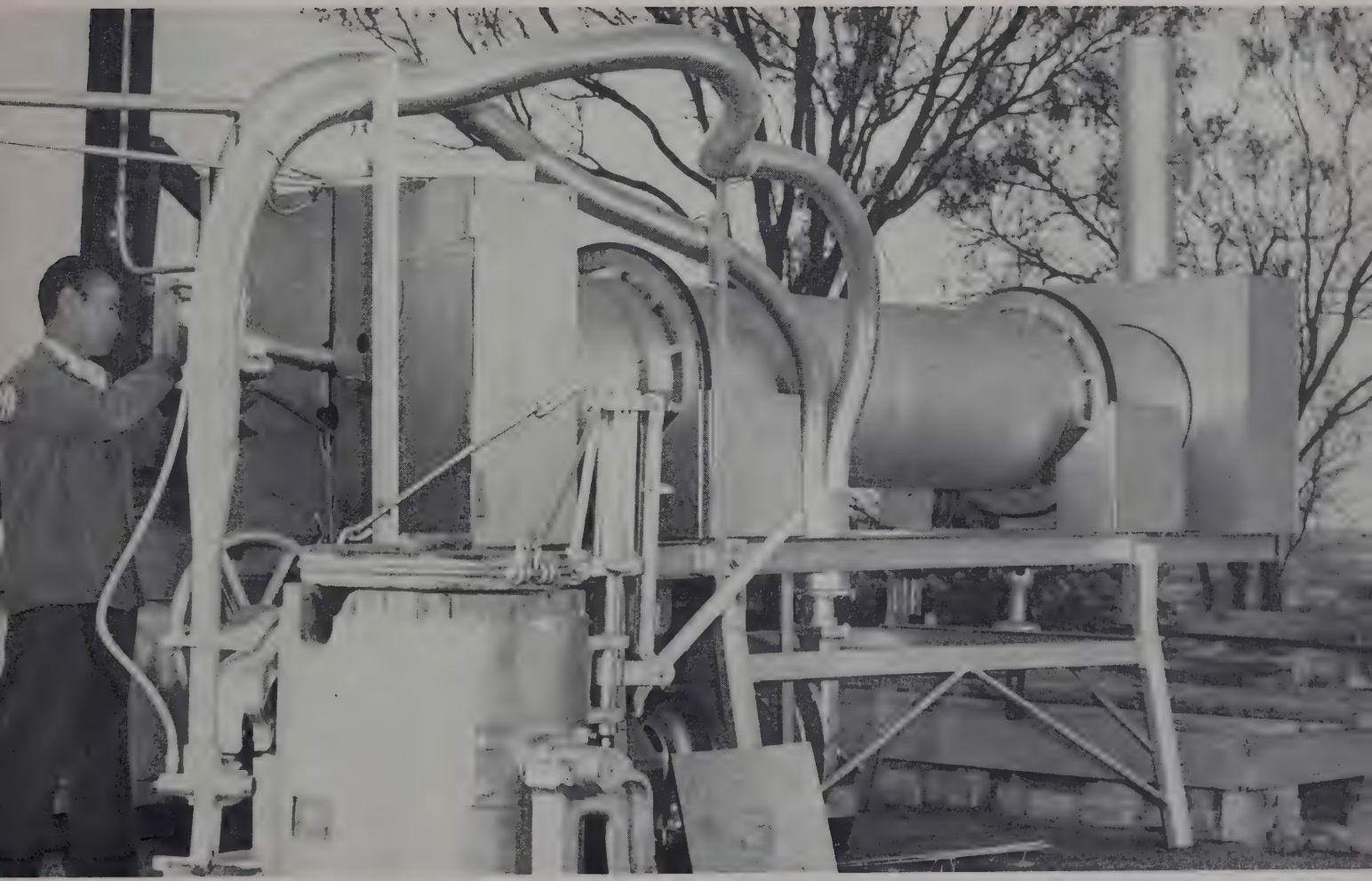
The activities of the department have covered such fields as geological and mineral surveys, fundamental studies of the utilization of industrial minerals, economic geology, mineral benefication and processing, investigation of clays and other ceramic materials, soil mechanics, glass, refractories, the production and use of lightweight aggregates, and ceramic technology.

The work carried out is of broad scope and frequently makes use of the services of chemists, mechanical engineers, soil technicians, and other members of the Institute's diverse technical staff in a well-rounded program of mineral and related technologies.

Mineral studies have included economic mineral surveys under varied sponsorships by the International Bank for Reconstruction and Development, the City of San Antonio, Texas, and the Del Rio Chamber of Commerce. Fundamental information was gained from these programs for economic considerations in the exploitation and development of mineral deposits.

Investigations in mineral processing have been carried out for several sponsors and have resulted in the successful treatment in pilot plant operations of various materials used in the production of lightweight aggregates and related products.

An indication of the wide geographical extent of the work done by the group may be gained from mention of mineral surveys and studies in the Virgin Islands, Mexico and Cuba. Continuous mineralogical investigations and evaluations are carried out in the laboratories through the use of microscopes, special furnaces, Geiger counter, chemicals and other technical equipment. Studies of both metallics and non-metallics are included in the work done by the department, with strong emphasis being placed on strategic and industrial minerals as related to national defense, industrial development, metallurgy, ceramics and numerous other related fields.



Developmental Kiln — Ceramics, Clay Products, Expanded Shales, Lightweight Aggregate Studies.

PHYSICS DEPARTMENT

INSTRUMENTATION. The Physics Department has recently inaugurated a development program involving a new instrument, the Vibrotron, for Interval Instruments, Inc. of New York City. The device is expected to have very wide uses in the fields of industrial and government instrumentation.

The Vibrotron is a basically new type of transducer which can change variations in any very small physical quantity, such as pressure, physical length, temperature, or velocity, into an electrical voltage that can be measured very accurately. The basic principle of the Vibrotron is that a fine wire, vibrating in a magnetic field, generates an alternating current of the same frequency as the natural frequency of the wire. Vibration is sustained by a simple feedback circuit.

Specific applications of this instrument are anticipated in a variety of fields such as telemetering, accurate measurement of chemical processing, temperatures, pressures, and rate of flow, measurements of meteorological quantities, and indication of drill hole bottom temperatures and pressures.

The Vibrotron program offers an opportunity for very interesting fundamental research in the field of transient response of a vibrating wire or string, in addition to the industrial application research and engineering required.

GEOPHYSICS. As a service to the petroleum industry, the Physics Department is initiating a program to screen proposed new methods of petroleum exploration. This program has been offered to the industry on a subscription basis.

The purpose of the program is to eliminate the duplication which occurs when the originator of a new prospecting method contacts a large number of companies within the industry, and it is necessary for each of these companies to evaluate the method for their own purposes. A majority of the new methods proposed do not turn out to be successful, although there is evidently room for considerable improvement of existing methods and the introduction of completely new methods.

Companies participating in this service will be able to refer all new methods for which they desire evaluation to the Institute, and all companies subscribing will receive a factual report of the advantages and disadvantages of the idea. The Institute will not express an opinion as to the value of a particular idea, but will endeavor to present all the pertinent facts in its report. Methods to be included in this program include surface and sub-surface geology, core drill, magnetometer, gravitimeter, seismograph, and other novel approaches, including geo-chemistry, that may arise. It is expected that the program will eliminate considerable duplication in effort by the various technical departments of the industry.

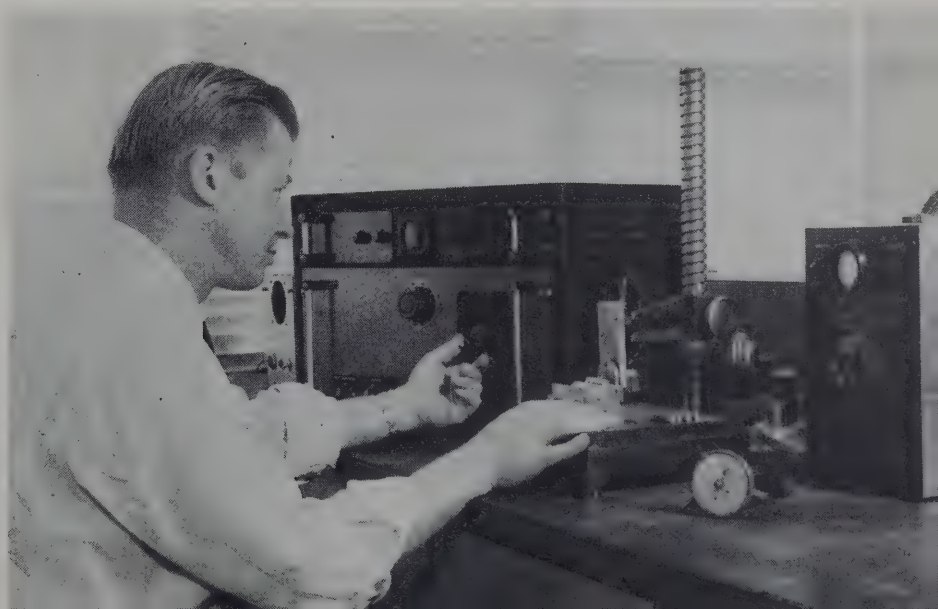
POULTER SEISMIC METHOD. Under sponsorship of the Institute of Inventive Research, the Physics Department

personnel have demonstrated the application of this new method of geophysical prospecting where multiple explosive charges are detonated above ground in a prearranged pattern. Two new oil fields have been reported by crews using the Poulter Method in areas previously shot unsuccessfully by conventional techniques. Facilities of the department include a complete seismic exploration mobile laboratory for field research investigations.

COMPUTERS. One of the purposes of the Physics Department's program in this field is to call the attention of moderate sized businesses to the advantages of employing computers in routine operations. Much of the publicity that has appeared on the subject of computers concerns large and complex installations using hundreds or thousands of vacuum tubes and requiring the attention of a large, highly trained staff of engineers, mathematicians, and technicians. While such computers have a definite place in the field, there are now in use thousands of small, relatively simple units which solve the problems of science and industry at very reasonable costs.

Southwest Research Institute is in an ideal position to furnish computing services to groups of companies in the same field of endeavor on a part-time basis. It is visualized that computing facilities in a variety of fields can be established at the Institute and made available to any user desiring such services on the basis of a nominal fee. In this connection, considerable thought has been given to the computing requirements of the insurance industry, of municipal traffic control problems, and of complex mathematical problems, such as the determination of a rate structure for the infant air freight industry. Work has been done in the general field of pointing out to representatives of the federal government that computing facilities in the Southwest are desirable from the standpoint of military security. On a long-range basis, it is expected that work in this field may be undertaken for one or more government agencies. In this connection, several proposals have been presented to groups such as the Office of Naval Research and Frankford Arsenal on the general problem of storage of information in a form which may be readily introduced into computers.

ELECTRONICS. In the field of electronics, the Physics Department has undertaken a project for the Institute of Inventive Research for the design and construction of a basically new type of vacuum tube. The Institute of Inventive Research has applied for several patents on this type of tube, which may be described as a "gas amplifier" tube. A fundamental investigation of the general effects of gas pressure in amplifier tubes has been carried out, and design of the new tube has been completed. It is planned to construct twelve of these tubes so that measurements will show whether consistent performance characteristics can be attained. If the project is successful, the gas amplifier tube may be expected to give relatively large power output for a very small voltage input and will be useful in controlling



Vibrotron Transducer Measures Extremely Small Differences in Diameter of Machine Cylinders.

such devices as solenoids, relays, and other units requiring a low impedance power amplifier. Staff members have observed and photographed striation effects not previously observed by workers familiar with this field. In the study of such effects, it may be possible to develop entirely new concepts in the general theory of gaseous discharge tubes.

ACOUSTICS. At the request of the Fire Technology Division, the Physics Department has engaged in a fundamental study and laboratory investigation of a new field, the extinguishing of fires by the use of acoustic energy.A thorough bibliographical survey of all available literature indicated the surprising fact that no extensive work has been carried out in this approach to the problem of fire fighting.

Preliminary tests in the laboratory using small flames and low power sources of acoustic energy show that it is possible to extinguish flames by this method. A number of related effects on flames have been noted, and it is thought that a patent position in this new field may devlop as a result of the basic work. The method is thought to have particular application to the control of fires in enclosed spaces, such as aircraft engine nacelles. More extensive work on this subject may show that it is possible to control relatively large fires with the use of moderate amounts of energy.

METEOROLOGICAL INSTRUMENTATION. The Vibrotron, mentioned in a previous paragraph, appears to have far reaching applications in the field of meteorology. The Institute is planning an extensive project for the design and development of automatic weather stations which can be placed in remote locations and will continuously transmit information on meteorological quantities, such as wind direction and velocity, barometric pressure, temperature, the amount of rain or snowfall in a given period, and so on.

INDUSTRIAL MEASUREMENT AND CONTROL. The Physics Department is engaged in work for sponsors who have expressed the wish that its nature and extent be kept confidential. The general field is that of the measurement and control of industrial processes, using electronic instrumentation. Electronic equipment may be used to count, sort small objects, to obtain rapid heating of metals or dielectrics, to give remote indication of the rate of flow of liquids, the amount of rotation of elements of machinery, and a variety of other uses.

GENERAL. The activities of the Physics Department have largely originated during the past six months period, since the building now occupied was completed about July 15 of this year. Technical personnel in the department now number ten, of which six have been added in the past five months. In addition to the activities described above, early expansion into fields of physics such as spectroscopy and atomic physics is planned. This expansion will be based on the general needs of the Southwest and the nation for these types of activities and on a number of specific ideas which have arisen in the brief period of operation of the department.

Integrator for Converting Differential Pressure Measurements into Total Quantity of Fluid Flow.

LIBRARY AND BIBLIOGRAPHY SERVICES

Southwest Research Institute's library has approximately 10,000 volumes of scientific and technical literature and is growing steadily. Its collections have expanded to such an extent that many business concerns, professional organizations and schools in the Southwest use it continually.

The library also is headquarters for a translation project of the Special Libraries Association. This project maintains an index which locates translations of foreign technical articles available in the United States and provides a directory of people who are competent translators of technical articles written in foreign languages.

Section of Institute's 10,000-Volume Technical Library.

AFFILIATED ORGANIZATIONS

Affiliated with Southwest Research Institute are the Foundation of Applied Research and the Institute of Inventive Research, all three of which operate in close collaboration under the same administration, but with different objectives. The Foundation of Applied Research works primarily in fundamental phases of biology, biochemistry, and agriculture. The Institute of Inventive Research screens inventions that are submitted to it and selects those that seem to be in the public interest most suited for commercialization. Summary reports on the activities of each of these affiliated organizations follows:

FOUNDATION OF APPLIED RESEARCH

The Foundation of Applied Research concentrates on medical, agricultural, and public health problems, approaching these from the basic and fundamental point of view. However, an attempt is made to select those problems that will, in time, have practical application as distinguished from the long range research which has no immediate practical application in view. Work in the Foundation is supported by grants from individuals, foundations, companies or government agencies, and is usually of such a nature that results can be published in the various scientific journals. In other words, the type of research done in the Foundation is similar to that done by colleges and universities and, as a matter of fact, the Foundation has working arrangements with universities in the immediate area that provide for the use of Foundation laboratory facilities by students in advanced work in biochemistry and biology.

LEUKEMIA AND CANCER. This program is primarily concerned with basic problems and long range objectives. Problems involving the biochemistry of cellular growth and antibiosis have received special emphasis. The physiological responses of micro-organisms to known antibiotics may have direct application in the chemotherapy of leukemic cells and tumors. Certain investigations have yielded interesting results on the role of vitamins on tumor growth and incidence. Studies are also in progress dealing with the effects of certain hormones. Host age was shown to be a very important factor in relation to growth of some tumors.

Experimental work concerned with more immediate objectives has dealt particularly with screening for anti-leukemic substances. Many materials obtained from biological sources as well as special synthetic compounds have been tested.

This general program has been supported by grants-in-aid from the American Cancer Society, Mr. and Mrs. Tom Slick, Mr. and Mrs. Lewis J. Moorman, Jr., Mr. Arthur S. Bird, and G. D. Searle and Company.

EGG TRANSFER. In the egg transfer research program, an effort is being made to take the eggs from pure bred cows, artificially inseminate them, and transfer them to ordinary grade cows which act more or less as incubators. By this means, it might be possible to produce pure bred calves from grade cows, and by super-ovulation in the donor it is possible that a single pure bred cow could have numerous off-spring in any one year. There are many fundamental problems in animal physiology that must be solved before the procedure will become practical. Dr. M. C. Chang, on leave of absence from the Worcester Foundation for Experimental Biology, has been added to the staff to expedite the program. This project is being financed primarily by Foundation funds, with the support of a fundamental research grant from Swift and Company.

HUMAN PATHOGENIC FUNGI. Over one thousand fungus specimens isolated from human exudates and so forth were examined the past year in search of fungi pathogenic to humans. Over 30 were definitely identified as pathogens. Some of them were rather unusual, while others were found to occur more frequently in this area than previously suspected. Some of the patients had been chronically ill for several months to over five years, and previously undiagnosed. Correct diagnoses followed by proper treatment resulted in rapid recovery. This work was carried out in cooperation with local hospital and clinical laboratories, while searching for patients to be treated with Tridine. A report on three cases was presented to the Society of American Bacteriologists on November 18, 1950.

ALLERGENIC MOLD EXTRACTS. These are constantly being prepared by the Foundation and distributed to various practicing physicians, with the expectation that these extracts will be useful and a demand for them created.

CORTISONE. The Foundation is continuing its search for cortisone producing plants. Much of the work to date is in the form of accumulating literature and references dealing with cortisone precursor producing plants. One plant exploration trip was made into Mexico and plants were investigated that are being used by the natives for medical purposes in the treatment of arthritis. Another plant exploration trip was made along the coast near Rockport, Texas, in search of plants that may contain cortisone precursors. Additional trips are being planned for that area. Cortisone yams were located growing in the Rio Grande Valley and in Oklahoma.

A total of 113 rooted cuttings of the African **Strophanthus** and related plant species were received from the U.S.D.A. Agricultural Research Administration. These plants were planted in the laboratory grounds and are being tested in order to determine if they will grow in this area.

CHLOROSIS. This is still one of the chief problems of plant growers in South Texas. A large number of plants have chlorotic tendencies. Apparently there are numerous causes that can bring about chlorotic conditions in plants, some of which are still unknown. Chlorotic conditions were successfully controlled on certain plants by the application of plant minerals to the leaves in the form of a fine spray. Plants failed to respond when these same minerals were added to the roots of the plant. The problem of chlorosis is one that will require much work over a long period of time.

MESQUITE THORN INJURIES. A study of the effect of a mesquite thorn upon the human eye was made. It is a known fact that such an injury is more than just a mechanical one. A study of the fungi, bacteria, and chemicals found on the tips of mesquite thorns was made, in cooperation with one of the local ophthalmologists.

PAPAYA. The overwintering problem of papayas for the Southwest area was studied. It was determined that hilling up papaya plants with soil to a height of 12 to 14 inches was adequate to keep the roots from being killed at temperatures as low as 14° F. Cutting the stems after the freeze and coating them with hot paraffin will inhibit rotting of the stumps. The papaya plants were treated with various hormones in order to study their effect upon the growth of this plant. Some of the plants were retarded in their growth when hormones were injected into the hollow stem with a hypodermic needle. Hastening the ripening of the fruit is now being

Operating Chopping Machine in One Phase of Experimental Brush Control Program.

Phase Contrast Microscope for Examining Living Organisms.

attempted. The hormones used are applied with a sprayer and injected into the hollow stem near the fruit.

BIO-ASSAY OF 2, 4-D CONTAMINATION. The papaya plants were also used for the purpose of detecting 2, 4-D contamination in insecticides. This proved to be a successful procedure and results are being published. The effect could be noted with dilutions as low as 0.5 ppm of 2, 4-D, and the technique is standard procedure at Southwest Research Institute where its practical use is reported under **Insecticide Contamination** in the Agriculture and Chemistry Department section.

NEW AGRICULTURAL CROPS. The Foundation has been active in the introduction of new grass varieties and has had particular success with a species of Cenchrus bilflorus, sometimes known as **Buffel grass,** imported from Australia in 1947. This grass shows higher protein content than most pasture grasses, and preliminary work indicates that it grows well in certain parts of the Southwest area.

Variety tests are being conducted on grain sorghum, in cooperation with the Texas Experiment Station at Lubbock. Certain varieties were shown to be particularly adapted to this area. It is drought resistant.

The Foundation is actively continuing its work on guar, a plant native to India, which is a crop particularly well suited to the Southwest and one which not only builds soil fertility, but produces a seed which has excellent industrial potentialities. This year two new varieties are under investigation and one of these shows particular promise.

Several range grasses are under study on experimental plots to determine their suitability for the area. This work, together with large acreage areas under test on Essar Ranch, is being done in conjunction with Texas Research Foundation at Renner, Texas.

PUBLICATIONS. During the past year the following papers were published by members of the Foundation staff:

Werthessen, N. T. & J. B. Loefer, 1949. Unio. Int. Contra Cancrum, ACTA 6:555-7.

Dyme, H. C., 1949. Tex. J. Sci. 1:13-25.

Loefer, J. B., 1949. Tex. J. Sci. 1:92-4.

Bieberdorf, F. W. & J. W. Argabrite, 1949. J. Allergy 20:50-55.

Bieberdorf, F. W. & G. E. Wilson, 1949. Tex. Repts. Biol. Med. 7:82.

Umbaugh, R. E., 1949. Am. J. Vet. Res. 10:295-305.

Bieberdorf, F. W., 1949. Proc. So. Br. Am. Pub. Health Assn. 43-44.

Loefer, J. B., F. W. Bieberdorf & R. G. Weichlein, 1950. Tex. Repts. Biol. Med. 8:105.

Bieberdorf, F. W., 1950. Tex. Repts. Biol. Med. 8:107.

Loefer, J. B. & V. M. Guido, 1950. Tex. J. Sci. 2:225-33.

Brunner, H. & F. W. Bieberdorf, 1950. Trans. Amer. Acad. Ophthalmol. Otolaryngol. May-June: 595-7.

Loefer, J. B., 1950. Anat. Rec. (In press).

Loefer, J. B. & M. R. McDaniel, 1950. Anat. Rec. (In press).

Loefer, J. B., 1950. Physiol. Zool. (In press).

INSTITUTE OF INVENTIVE RESEARCH

Briefly, the Institute of Inventive Research was founded to aid general welfare through development of inventions, to create a living endowment for the support of fundamental research, and to aid the inventor in the commercialization of inventions which otherwise might not reach maturity.

During the year emphasis on the screening and evaluation of thousands of unsolicited inventions was shifted to development and marketing of a number of carefully selected projects which had been received during the preceding months. Temporary restrictions were placed into effect limiting acceptance of inventions to those requiring minimum development and confining the fields of interest to those in which the Institute has set up major projects.

ESTABLISHMENT OF CONTACTS ABROAD. During the year, a number of contacts have been made abroad for the purpose of routing to the Institute selected invention assets from several foreign countries. Contributing to this desirable advancement has been the establishment of a Paris office which serves all three organizations. An able and well known engineer, S. G. Cantacuzene, forwards to the Institute those projects which he selects from various European countries.

Representing the British Isles, a cooperative arrangement was recently concluded with the Amalgamated Research and Development Company, which is an organization with a background of service to English industry and numbers among its directors prominent industrial leaders. The arrangement provides for the cooperative licensing of foreign inventions here while affording the Institute an extremely good entree to Continental markets.

To further the relationship of the Institute of Inventive Research to the international field, staff members visited business leaders in a number of European countries, the British Isles, Mexico, and several South American countries.

INSTITUTE-SPONSORED DEVELOPMENT WORK. Research programs are being continued by the Institute on a number of its major developments. The Poulter Seismic Method has been the subject of a project at Stanford Research Institute since 1948, while Southwest Research Institute has made defiinte contributions to the improvements of basic techniques of the method through the operation of an experimental crew in the field.

Technical aspects of the Youtz-Slick Lift-Slab Method have been almost entirely developed in the Engineering Mechanics Department of Southwest Research Institute, while the Chemical Engineering Department has handled slab separation tests and studies of suitable materials for the purpose.

In addition, the Institute of Inventive Research has supported numerous other research investigations, as well as literature and patent searches, on many new developments that it has had under consideration as being useful not only for industrial development but also for the general public good.

INSTITUTE OF INVENTIVE RESEARCH PATENT ASSETS. During the past three years, the Institute has been investing the largest portion of its funds in patent assets. A limited investment has been made in small items, such as household devices designed for rapid development and rapid placement on the market for public use. Several patented devices have been licensed in the agricultural field, such as a garden seeder and a water-actuated spray gun. Industrial items, such as a tractor wheel adjuster and a load binder, have been licensed to manufacturers; other similar inventions are available.

The Institute is licensing several more complex inventions including a balancing machine for rapid elimination of vibration in rotors, several related electronic tube developments, biological products, and a refinery process. The Bassinger Drill, a hydraulic engine for oil well drilling, using a conventional bit to drill by percussion, was developed by the Institute and associates and is now being licensed to the industry by a company organized by an investment group to market this one invention. Several of the items received from abroad, including a plastic zipper and a vapor-saving storage tank, have received favorable reaction in this country and will justify the Institute's efforts in the international field.

POULTER SEISMIC METHOD. During the year, a great deal of progress has been made on the perfection of field techniques by employing the Poulter Method in seismic prospecting on an experimental basis. Areas in the Edwards Plateau of West Texas have been successfully mapped geologically for the first time by use of the method, and at greatly reduced cost of exploration. The field research programs have not only contributed to the improvement of seismic records but have resulted in further discoveries embodied in additional patent protection.

Nine United States patent applications have been filed, and through special proceedings prompt issuance of U. S. patent protection, in the best judgment of patent counsel, is assured. Sixty foreign applications have been filed, on which twenty-seven patents have issued.

Use of the Poulter Method in foreign countries has increased and will continue to do so as companies learn of the adaptability of the method to remote arid regions because of the portability and absence of drilling of shot holes.

YOUTZ-SLICK LIFT-SLAB METHOD. Most active of the major projects of the Institute is the licensing program presently under way on the Youtz-Slick Method. Following the successful completion of the Administration Building, first unit on the Trinity University campus, widespread interest has developed in this building con-

struction method. In addition to a very low cost figure of $6.70 per square foot, the lift-slab structure was completed in such a brief period of time that those supplying the finish materials were caught unprepared, having refused to believe the accelerated construction schedule promised them.

The licensing program on the Youtz-Slick Method is designed to make available the services of building contractors of unusual skill. Not only will licensed contractors use the method in their own general contracting business but they will also act as lifting contractors for others. One company has been organized to act only as a lifting contractor. England, Australia, New Zealand, and several African countries as well as Latin America should soon have the method available to them through additional licensees with whom negotiations are being conducted.

License arrangements already concluded on the method with four licensees have provided substantial advance royalites assuring continuation of adequate research programs so that basic fundamental research in this phase of building construction can be carried on in a comprehensive manner, while additional contracts now in negotiation will add increased funds.

Buildings already constructed or in the process of construction by this method include three houses built by Mr. Youtz, the Electronics and Physics Laboratory and the Mechanical Testing Laboratory on Essar Ranch, Trinity University Classroom and Administration Building, the William Dick residence, the Altman Factory, and the Trinity University Dormitory, in San Antonio, Texas.

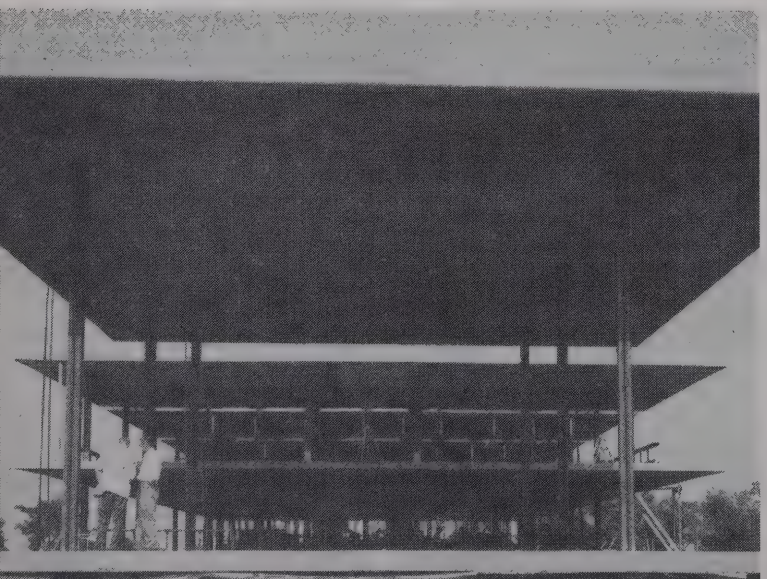
Proposed construction includes service stations for one of the major oil companies, the Science and Library buildings at Trinity, a large elementary school building in South Texas, local housing projects as well as large units in Texas and other areas, and a hospital in the Rio Grande Valley of Texas.

THE FUTURE. The development of patent assets is a process requiring a definite period of time so that only now can inventions accepted for development in the early days of the Institute reach complete commercial maturity. More and more the Institute is stressing the procurement of inventions through carefully planned channels rather than devoting great effort to thousands of unsolicited ideas in all degrees of development.

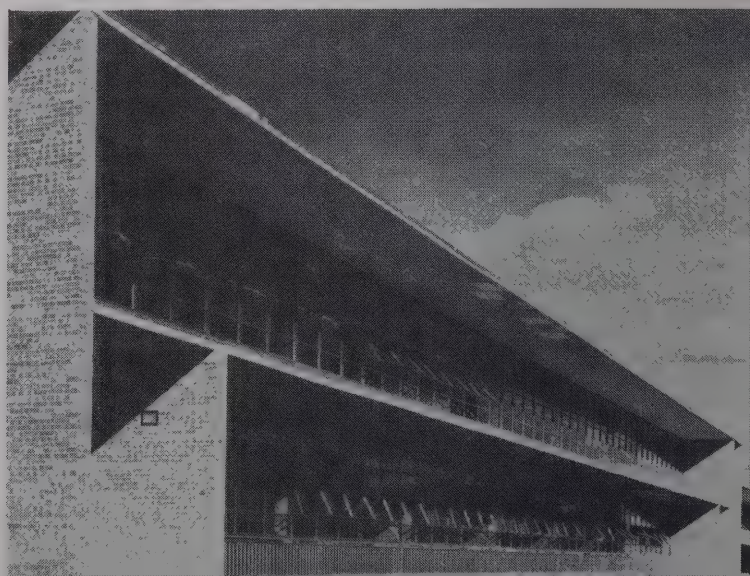
Management of patent assets is a profession unto itself. A combination of patent law, engineering skill, market analysis and business acumen is needed. These attributes are available to the Institute through its associates and its staff. The Institute plans to make use of these to develop the present assets to their greatest value and add projects of equal or greater import.

Industry is beginning to realize more and more that the Institute and its affiliated organizations represent a center of new ideas, new processes, new products and new opportunities that will not only enhance their own prosperity but at the same time provide new and improved consumer goods to the general public.

Section of Trinity University Building Constructed with Youtz-Slick Lift Slab Method.



Youtz-Slick Lift Slab Building Method Used Commercially.



PUBLIC SERVICE

In addition to their research activities, the institutions on Essar Ranch perform a number of public services to the community, the area and the nation that seem to have real value. It is recognized that one of the objectives of the over-all organization is to contribute to the enhancement of regional development through the utilization of natural resources, particularly in the Southwest area, and to develop through its educational activities a better understanding on the part of the general public as to what research can do in the public welfare.

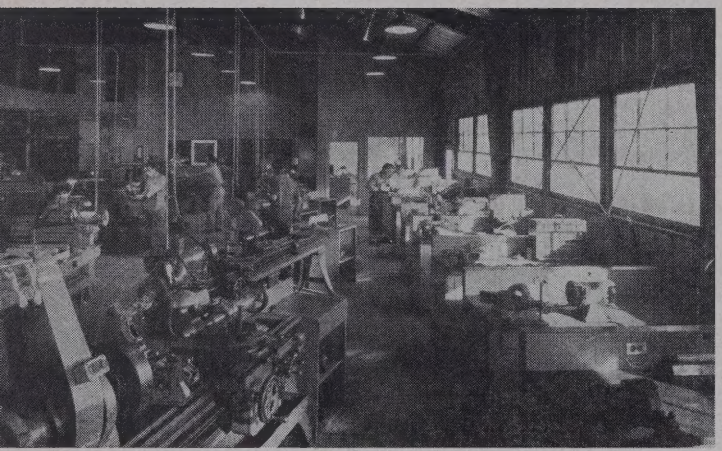
As part of their educational activities, the institutions are providing the services of several of the members of the staffs to instruct in recognized universities in the area on both the graduate and undergraduate levels in the fields of their specialties.

The Institute library is available to the general public and its use steadily increases. The library staff during the year made substantial progress in coordination of the library with those of other organizations in the area.

The institutions are rendering, without cost, an advisory service to hundreds of individuals and small companies through the year who have minor technical problems on which there is a ready solution, and in this way assistance is given in the sound planning of economic development.

Many members of the staff have appeared repeatedly before public groups to discuss the progress of science and technology and to point out how this plays an important part in our future prosperity and public health and well being. During the year the staff has published numerous technical and general articles on research.

Southwest Research Institute widely distributes its quarterly publication, "Tomorrow —Through Research."



Portion of SwRI Machine Shop Facilities for Fabrication of Pilot Plant Equipment.

ACKNOWLEDGMENTS

The preparation of an annual report provides a fine opportunity to express appreciation to the many people who have been so largely responsible for the growth and development of the organization. Great credit is due to the Trustees and Governors for their unselfish and invaluable assistance in the formulation of policies and procedures so fundamental in the formative period of development of an institution.

During the year there was great increase in the support of the objectives of the Institute by donors who made grants-in-aid for the support of basic research, by individuals and manufacturers who have contributed not only to the capital funds of the Institute but have given important contributions in a variety of equipment, all of which will enhance the services of the Institute, and by other friends who have contributed important works to our growing library and have otherwise assisted in the program.

In conclusion, the steady growth of the institution and the evergrowing realization of its value to state, region and nation compliments the vision and generosity of Mr. Tom Slick, its Founder. The year 1950 has witnessed fine progress. The staff has dedicated itself to even greater progress in 1951 and knows that this will be accomplished with the continued interest and support it has been receiving.

Harold Vagtborg

President.

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